Designing Green Supply Chains

A TriPoint Interactive Publication

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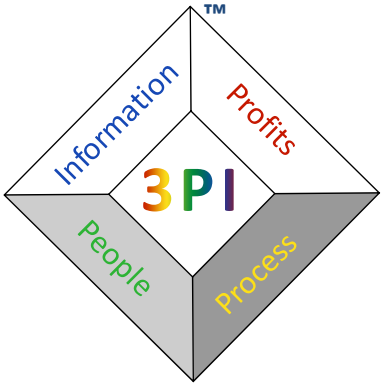

Supply chains are rarely designed from scratch. In fact, they sometimes seem to come about by chance as the organization evolves. In recent years, two paradigm shifts in thinking are renewing interest in overall supply chain design: 1) Driving supply and distribution center inventory based on actual customer demand or creating a lean supply chain; and, 2) Initiatives to reduce the organization's greenhouse gas emissions, referred to as its carbon footprint, or creating a green supply chain. We will focus on designing a green supply chain, but take advantage of lean ideas to meet our green goals as well.

Design tradeoffs must be made to create a green supply chain. The major areas are:

1. Sourcing strategy - as the source of products determines distance from major markets and the boundaries of the transportation solution.
2. The physical network - the number and location of warehousing and crossdock facilities, since this determines inventory levels and the cost to meet customer delivery requirements.
3. Customer order to delivery time - since this drives network infrastructure, inventory placement and mode of transportation.
4. The demand fulfillment strategy - or ability to pull inventory through the supply chain based on customer demand, which minimizes both wasted transportation and unneeded inventory.

The design becomes a circular problem, since changes in one of the design tradeoffs impacts the others. In our professional experience focusing on the transportation component of the supply chain is an excellent way to address this; since reducing transportation is also a good way to reduce cost and greenhouse gas emissions.

How to calculate the carbon footprint of supply chains?

To determine progress, you first must measure where you started from and where you are now. The sum of all greenhouse gas emissions from a process is referred to as its carbon footprint and the major contributor to greenhouse gases in most supply chains is transportation.

Unfortunately, calculating the greenhouse gas emissions, or carbon footprint, of a supply chain is not very well understood, and definitely not an exact science. Companies such as Wal-Mart, Tesco and Marks & Spencer are working with their suppliers plus various academic and governmental organizations to calculate their total carbon footprint, including the supply chain. You may find that your major carriers are already working on providing carbon footprint information to their large customers based on the cost of the shipment or other factors that can help you. The MIT Center for Transportation and Logistics is working on a Web-based tool to help companies calculate the energy consumption of products moved by land, water and/or air that is planned to be available late in 2008. The US Environmental Protection Agency (EPA) is working on a similar model. For the facilities impact, contact the utilities in the relevant geographies to request the carbon footprint of your energy use.

Transportation improvements impact both cost and carbon footprint

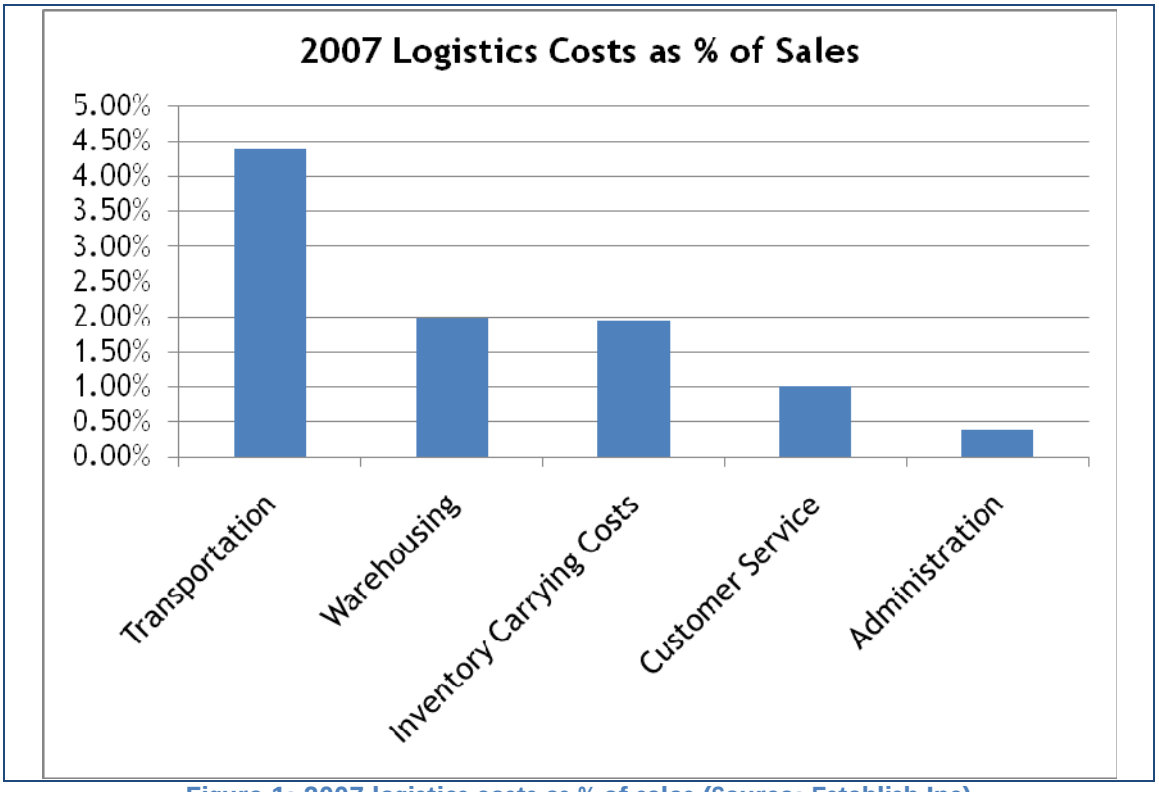

Figure 1: 2007 logistics costs as % of sales (Source: Establish Inc)

With a measurement plan in place, the next logical step is to concentrate on conservation, since a conservation strategy is the most cost effective approach, and the one that provides the quickest results. Conservation efforts focused on transportation generally offer the most benefit. In a survey conducted by Establish Inc. transportation constituted 4.4% of sales or more than twice the cost impact of any other logistics component.

In the United States, the most recent EPA report concludes that CO2 emissions from truck and rail transportation grew 64.1% (the truck portion grew 69.4%) in the period 1990 to 2005; while the U.S. gross domestic national product increased just 55% over the same period.

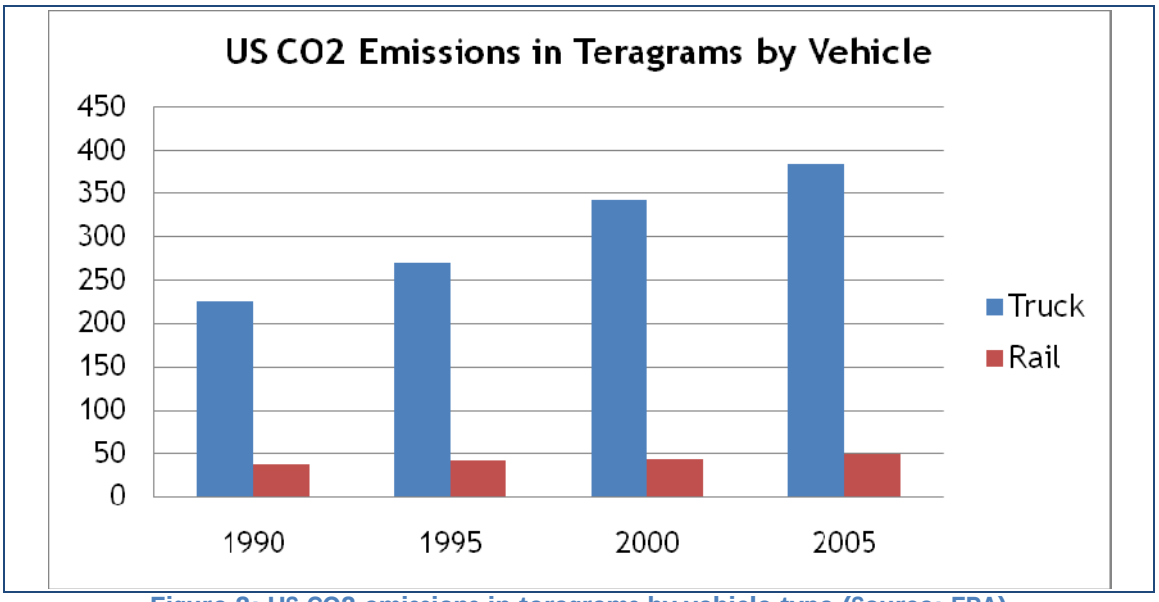

Figure 2: US CO2 emissions in teragrams by vehicle type (Source: EPA)

Transportation represents both the highest cost in most supply chains and the source of most greenhouse gas emissions. Luckily, the strategies to reduce cost in transportation also tend to reduce greenhouse gas emissions. And, transportation also tends to be the easiest area to make changes; far easier than making major changes in the sources of supply or number of warehouses or converting to a demand driven philosophy.

There is a strong relationship between transportation modes with the lowest cost per weight transported a given distance (ton-mile) and the associated energy use. The list below attempts to rank transportation modes based on energy use and contains several implicit assumptions; so the list is more of a guide to be used with due consideration to appropriate mode, shipment weight and cube, length of haul, and service time. Within these assumptions, the transportation modes sorted by energy use per ton-mile transported are:

1. Ocean and inland waterway (least emissions per ton-mile)
2. Rail

3. Intermodal, a rail/truckload combination using trailers or ocean containers on flatcar (The EPA estimates that for shipments over 1,000 miles, using intermodal transport can cut fuel use and greenhouse emissions by about 65%, compared to a truck only move.)
4. Truckload
5. Multi-stop truckload
6. LTL and small package
7. Air transport

A good transportation design strategy is to plan a shipment on the most energy efficient mode first and then look for combinations of the modes to reduce the energy use of groups of shipments. For example, a company with a supply chain requiring delivery of three pallets weekly to 1,000 points might plan on truckload, multi-stop truckload or intermodal shipments to a LTL carrier's terminals, with the last mile deliveries made via LTL. This truckload/LTL, or pooling arrangement, is both less costly and a greener alternative to a pure LTL solution. One idea is to partner with other companies serving the same geographies, if not the same customers, to share the cost of a network. For example, several companies may share the cost of a truckload to points they could not serve as efficiently by themselves. It is likely that when the most appropriate mode or combinations of modes is used from a cost standpoint, it is also the most appropriate from an energy standpoint.

Other strategies to reduce energy use in transportation are:

- Utilize a Transportation Management System (TMS) to plan shipments in the most cost effective and energy efficient way; including the mode combinations noted above.
- Use trailer pools when possible to enable carriers to make pickups and deliveries without fuel expended in wait time and with a reduction in empty miles.
- Enforce "no idling" rules at your locations and institute appointment scheduling to minimize the wait time for drivers. (The EPA estimates that one hour of idling uses 1 gallon of fuel.)
- Offer truckload carriers continuous moves to avoid empty miles
- Use carriers that are committed to reducing their fuel use as part of monitored programs, such as the EPA's SmartWay program. The SmartWay program suggests the following strategies to carriers to reduce emissions:
  - Improved aerodynamics
  - Improved freight logistics – a variety of techniques that include load matching, more efficient routing and ways to reduce empty miles
  - Automatic tire inflation systems

  - Wide-base tires
  - Driver training
  - Low-viscosity lubricants
  - Reducing highway speed
  - Vehicle weight reduction
  - Hybrid powertrain technology

- Use carriers that purchase carbon credits to offset the calculated CO2 emissions of each shipment. (TransGroup Worldwide Logistics is one company offering such a program; although note carbon credits increase the cost of the shipment.)

Rules of thumb are for suckers.

After capturing the "easy" savings in transportation, take a broader look at the supply chain. It is better to work on an in-depth analytical approach to the entire supply chain rather than rely on shortcuts. You really do need to do the analysis and be totally data driven. Don't listen to those who want to put a warehouse next to each major customer or down the road from a major competitor. The author worked on the worldwide supply chain for a major corporation, where the transportation budget was over $250 million. The breakthrough in the analysis came from relocating a major distribution center (DC) from the UK to the Netherlands. This DC location change made possible significant transportation mode changes to meet customer delivery requirements and generated almost 75% of the worldwide cost savings and carbon footprint reductions. Companies in the same industry can be much different in customer base, average shipment size, strategies, service commitments, financial position, risk aversion and other factors that have major impacts on the analysis. Never assume another company in your industry has the ideal supply chain.

Given sources of supply, the network design problem is generally stated as: How many warehouses do we need, where should they be located, what products should be stocked and what markets should they serve? Be careful to think through what your goals are and how you might get there. Don't just acquire a distribution optimization model and "turn the crank" to get a solution.

Spend the time to develop a deep understanding of data and potential issues. Be especially careful of accounting data to ensure it matches operational realities. Try for at least a year of shipment data; and, if this much data is not available, take care that you consider impacts of seasonality in the missing periods. Continually look for elements of the business that may be missing in your data. You likely will spend more time on data acquisition and clean-up than you plan.

Here is a process suggestion for data clean-up:

1. Sort a year of transportation data into lanes (origin and destination pairs) and calculate the range for cost per shipment and weight per shipment. Look for data entry errors (the 100,000 pound shipment or $300 coast to coast truckload), missing data (missing origin, missing destination, zero cost shipments and similar), inappropriate data (inclusion of customs duties with transportation costs) and summary data shown as a single shipment (a week of container drayage for example).
2. Activity Based Costing can be helpful to provide transportation costs and warehouse costs by product unit. Look for extreme cases in this data that imply a need for major changes or a different logistics network than the remainder of the product assortment.
3. Run a report to summarize customer returns, and cancelled orders by month by product group by channel, since this data is an indicator of the level of "mistakes" in the current customer process. Run a similar report of inventory turns by product group and location.
4. Ask knowledgeable personnel about unusual events. A spike in warehouse costs could be due to overflow warehousing to handle a unique, one-time event. Perhaps a strike, unusual weather, gain or loss of a major customer or other unusual event influenced the data.
5. Decide on filters to toss out data that will distort the analysis.

In conducting the data analysis, be aware of the kinds of issues with the current supply chain that can introduce higher costs and inefficient energy use.

Typical issues:

- Allocating product from either production or suppliers to the wrong DC. (Sometimes organizations with sophisticated processes for managing inbound raw materials and outbound orders will use rules of thumb for internal supply chain product allocations, such as allocate 80% of all products to the East Coast DC and 20% to the West Coast DC. One company found it was spending over $1 million annually to ship product between DC's due to using rules of thumb for allocation of production. Switching to a demand driven allocation by product corrects this error.)
- Assigning customers to the wrong DC (Look for major customers assigned to the DC with the most inventory rather than the DC best able to support the customer from a cost and energy standpoint.)
- DC's in the right geography, but wrong location within that geography (For example, a client moved a DC an hour outside of a major metro area to reduce costs, but then found their cost savings were eliminated by added drayage costs from the container ramp.)

- Suppliers shipping to a DC instead of directly to customers (In the worst cases, supply chains are set up so suppliers send product into the country with the largest market, and then reship the product to a country close to the supplier. If customers order in full truckloads or carloads, review the required order to delivery time to determine if you can ship them directly from the source and bypass the DC.)
- Failure to use a supply chain already in place for new business. (For example, because of a different ordering system or marketing channel, new warehouse and transportation lanes may be set up to support a major market already served by the supply chain. One company introduced a new office product to the US market and marketing paid to have the initial shipments by air to speed up deliveries. A later audit found the company spent $78 million more on air transportation than needed if the shipments went by ocean, because the cost continued to be assigned to the marketing budget, and no one switched the shipments to ocean.)
- Using the supply chain for products that are not appropriate. (This can easily happen with very large product assortments, where new products enter the supply chain that it was never designed for. Hint – if the cost of transportation is more than the selling price of the item, find another supply chain.)

Green facilities design

With a thorough analysis determining the number of buildings and the optimum locations, work can start on including environmental considerations in the building designs. Facilities already in place can sometimes be retrofitted to use these ideas. Here are some examples of environmentally sound ideas from a Patagonia warehouse built in 1996 in Reno, NV and a 467,000 sq. ft. building designed by ProLogis for Anixter International and opened in 2007:

- Architectural elements that emphasize the use of natural light or special mirror and lens arrangements that replace standard skylight to direct sunlight into building interiors
- Extensive use of recycled and locally sourced materials used during construction; such as drywall replaced with compressed straw, carpets made from recycled plastic, and stairs from recycled steel and hardwood
- An HVAC ventilation system that reduces power consumption and improves air quality for warehouse personnel
- Energy efficient artificial lighting under computer control that senses when space is occupied to adjust light levels
- High efficiency roof insulation for greater resistance to thermal heat transfer
- Low maintenance landscaping, bioswales and water-efficient irrigation
- Non-carbon power sources such as solar panels.

The economics are changing for the use of solar panels to at least partially offset power generated through fossil fuels. When Patagonia installed solar panels to provide 5 kilowatts of power in 1996, they projected a payback period of almost 20 years for the installation. However, a recent Wal-Mart Sam's Club store project claims a 390 kilowatt solar installation will generate net savings from the first day of operation, with no upfront capital costs, as the system was financed via the manufacturer's (SunPower) power purchase agreement.

For more information on this area, reach out to the U.S. Green Building Council (USGBC). The USGBC has a rating system for determining the environmental impact of design alternatives for both new construction and retrofits.

Improved green analysis of sourcing decisions and customer requirements

Some companies are looking beyond cost, product, quality and delivery performance to make sourcing decisions. In Europe there is talk of using a carbon credit calculation as part of a total landed cost metric to compare vendors. Certain large players, like Wal-Mart, are instituting packaging reduction programs and other environmentally driven changes in their customer requirements.

What the future holds

It is likely that current trends of rising economic, environmental and social costs due to fossil fuels will continue; perhaps accelerate; and companies will have to give greater weight to environmental factors within their operations than in the past. Industry will likely face pressures to reduce their carbon footprint faster than the general population, because most industry related activities are a source of concentrated emissions. Large companies will lead the way with increasingly stringent environmental mandates on their suppliers. Companies will begin to compete based not only on cost, product, quality and delivery; but also on environmental impact.

Market forces will also create changes in supply chain design as profitable customer segments demand innovative green solutions from producers. Companies will need to evaluate the public relations aspects of their carbon footprint and how they are perceived as either leaders or laggards in creating environmentally sound solutions. Look how quickly products labeled "organic" entered the supermarket product assortment. How quickly will the term "carbon neutral" or similar gain popularity?

Governments at all levels are weighing alternative ways to reduce the use of fossil fuels and incent both their populations and the industries that serve them to operate in a more environmentally friendly way. (While the looming issue of global warming is driving action among many nations, the goals to reduce dependence on fossil fuels and improve the quality of life in large population

centers are also factors.) The environmental regulation of supply chains will increase; possibly driven by regulation in the most stringent country of the supply chain being applied to the entire supply chain.

Computer models are becoming available to calculate the total supply chain carbon footprint for both “As Is” and “To Be” designs. These models can be used to create regulations for controlling industrial energy use. For example, the recent effort in London to effectively bar the use of energy inefficient freight vehicles in the city was based on performance data by truck type. Information technology will play a larger role in designing supply chains and assisting to direct the day-to-day operations within environmental tolerances.

Continuous improvement activities in supply chains will need to consider not only cost and customer service, but environmental goals. A good strategy is to source product as close to major markets as possible, use demand driven techniques to keep inventories low and design for minimum transportation costs.

While a clean sheet design has appeal, great strides can be taken with an existing supply chain by staying up-to-date with the changing economics of environmentally friendly technologies in order to adopt these technologies as they become cost effective. Great strides can also be made by emphasizing a conservation approach and by eliminating the mistakes that emerge in any large, complex supply chain. In the future, most companies will have annual carbon footprint reduction goals and will be monitoring their progress in meeting those goals.